REPORT NO. 82-2-10

3430
April 1982

# CUT-AND-LEAVE AND CUT-AND-TOP TACTICS FOR SOUTHERN PINE BEETLE SUPPRESSION

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*Abstract*

*Evaluations were made in three States from 1975 through 1978 to determine if the cut-and-leave tactic for treating individual southern pine beetle infestations was effective in preventing spot growth. In 1975 and 1976 the cut-and-top tactic was also evaluated. Because of declining beetle populations in North Carolina (1975-76) and Louisiana (1977), the evaluations were inconclusive. In Mississippi (1978), management constraints precluded a definitive evaluation. This report discusses the cost of treatments, landowner objections, and conditions under which evaluation of control tactics could be made.*

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## INTRODUCTION

In 1970, at the height of the most recent outbreak of the southern pine beetle (SPB) (Dendroctonus frontalis Zimmermann), the pest was found on more than half the region's pine land. Records show that 8.5 million cords and 2.5 million board feet of beetle-damaged pine timber were salvaged from 1960 through 1978. This timber has been valued at $200 million (Price and Doggett 1978). It was estimated that only one-third to one-half of the beetle-affected timber was salvaged. During this same period, State and Federal agencies spent over $12 million on SPB suppression programs.

Currently, four suppression methods for SPB are recommended in various combinations: (1) salvage removal, (2) cut-and-spray, (3) pile-and-burn, and (4) cut-and-leave. A fifth method, cut-and-top, has had limited use in Texas. Salvage removal is the most widely used of these methods. Often inclement weather conditions, administrative delay of sales, low volumes of timber, inaccessibility of spots, or a poor timber market severely limit the effectiveness of the salvage-removal programs. During such times, the other suppression methods offer advantages.

Cut-and-spray and pile-and-burn, although still used sometimes, are potentially hazardous treatments. Because of the few acres sprayed each year, an environmental problem using lindane or chlorpyrifos (Dursban 4E®) has not been encountered. There are, however, potential risks associated with the formulation and application of these insecticides. In addition, these chemicals are costly to apply. Pile-and-burn must be restricted to times when the risk of forest fire is low. Air pollution could also be a problem in some areas. Clearly, we need alternative SPB control tactics that are both economical and potentially less harmful to the environment.

Two such tactics--cut-and-leave and cut-and-top--are relatively easy to apply. It has been shown that cut-and-leave reduces SPB population survival (Ollieu 1969), disrupts natural aggregation behavior (Gara 1967), promotes dispersal, and reduces subsequent tree mortality (Billings and Pase 1979). Agencies using the cut-and-leave method include the Texas Forest Service (Texas Forest Service 1975), the Virginia Division of Forestry and the Georgia, Mississippi, and Tennessee Forestry Commissions.

The cut-and-leave treatment involves felling all infested trees into an opening created by dead "black- and red-topped" trees. This usually results in a large pile of infested trees. When the crowns are left intact the inner bark (phloem) moisture is naturally dissipated through transpiration.

The cut-and-top procedure is applied in the same way as cut-and-leave, except that the tops are severed from the bole. Proponents of the procedure believe that removing the top in the winter prevents transpiration and thus maintains abnormally high moisture levels for developing broods.

In both of the above methods, all hardwoods in the treated area should also be cut to eliminate any shading effects on the felled pines. A buffer strip of green pines (equal in width to the height of infested trees) is cut in front of recently attacked trees to prevent further attacks on adjacent trees (Coster and Johnson 1979). The disruption of the natural pheromone source apparently encourages beetles to disperse at a time when they may not be physiologically ready to do so (Hedden and Billings 1977).

The objectives of this evaluation were to determine if cut-and-leave and cut-and-top treatments effectively prevented spot growth and the establishment of new spots within a quarter-mile radius of treated spots. Information was also gathered on the cost of application and landowner opinions regarding the tactics.

## METHODS

### A. North Carolina--1975-76.

The first evaluation of cut-and-leave and cut-and-top took place on the Coastal Plain and Piedmont areas of North Carolina from September 1975 through September 1976. The North Carolina Division of Forest Resources conducted aerial detection flights. Then all spots containing pines with fading foliage were ground checked. When a spot was found to be active, the landowner was contacted to obtain permission to use the spot for treatment evaluation.

When permission was granted, the field crew collected the following data on each spot: number of trees containing live SPB, tree species, average diameter at breast height (d.b.h.), basal area, age, and forest type. All infested and buffer-strip trees were marked prior to cutting. When nine acceptable spots were found, they were grouped into three sets of three each. An attempt was made to select stands for each set with as nearly similar conditions as possible. One treatment--cut-and-leave, cut-and-top, or untreated check--was randomly assigned to each individual spot in each set. Seven sets were treated in the summer and ten in the winter.

District personnel with the North Carolina Division of Forest Resources conducted the evaluation. During the summer each of the 21 spots was visited at monthly intervals; spots receiving treatment during the winter were visited again the following spring. The periodic visits documented the extent of breakouts (tree mortality) at the margins of the spots. Each untreated check was examined every 2 weeks to record additional attacked trees.

In June and December of 1976, all spots were photographed from the air using color infrared film at a scale of 1:6,000. All new spots within one-quarter mile of each original spot were recorded. Any new spot was regarded as a proliferation from the original spot.

For purposes of statistical analysis, the winter treatments (October 1 to April 30) included 10 triplicates and the summer treatments (May 1 to September 30) included seven triplicates. Cochran's Q Test was used (Cochran 1950) to test whether breakouts or spot proliferations were different for treated versus untreated plots. The null hypothesis was that there were no treatment differences when comparing additional trees attacked at the spot's periphery and new spots within a quarter-mile.

B. Louisiana--1977.

The selection of the Kisatchie and Vernon Districts of the Kisatchie National Forest in 1977 for the second evaluation was based on the expected level of beetle activity (historical records and losses sustained the previous season), number of possible candidate stands, and availability of complete stand records.

The computer-based National Forest Continuous Inventory of Stand Conditions (CISC) was searched for suitable stands. The CISC characteristics used in stand selection included: forest type (loblolly, loblolly-hardwood, or shortleaf), stand conditions (immature or mature sawtimber), site index (> 70), acreage (20 to 200), and method of prescribed cut.

Following evaluation of CISC data, the district was visited to obtain compartment and stand maps. Potential stands were located on the compartment maps. With the advice of timber crews and checks of the resource photography, a list of 250 candidate stands was compiled. On the respective Districts, candidate stands were observed from the air by experienced sketch-mappers, who plotted all spots containing red and fading pine. Ground crews verified the location of spots in each stand and collected data on: stand basal area, numbers of infested trees, infested tree species, d.b.h., height, and basal area at the active head of the spot. The remainder of the stand was examined to determine if there were any additional infested trees present. When two similar spots were found, the cut-and-leave treatment was randomly assigned to one of the spots and the other spot left as an untreated check.

An adjacent zone at least one-quarter mile wide surrounded the stands containing the treated spots. All spots located in the zone adjacent to a cut-and-leave spot were to be treated. Spots in stands adjacent to untreated check stands were left standing. This procedure was designed to determine if cut-and-leave significantly reduced subsequent SPB-caused mortality within a stand.

C. Mississippi--1978.

The Strong River and Bienville Districts (approximately 80,000 acres) of the Bienville National Forest were selected for study in 1978. SPB activity was increasing in this area at the time (Rogers and Twardus 1976).

Beginning on June 15, periodic aerial sketch-map flights were made over the area. Aerial observers located all spots with 5 to 40 fading trees. Crews made additional flights when all ground checks of the spots reported in the previous flight had been completed. Spots with 15 to 40 trees were given first priority as potential study areas. On the first visit, investigators identified all active trees and determined the diameter, principal beetle brood stage, and basal area (pine and hardwood) at the head of the spot. All spots found to be active at the first visit were revisited 2 weeks later. At this time, all infested trees were identified and the principal brood stage determined. National Forest crews treated the spots under the supervision of State and Private Forestry.

This evaluation was designed to determine if the cut-and-leave treatment of SPB infestations significantly reduced volume loss within those stands from losses in stands around untreated spots. Paired spots were used to minimize the difference in brood stages, basal areas, and numbers of infested trees.

## RESULTS

### A. North Carolina.

There were no significant differences ($P < 0.05$) among treatments in the North Carolina evaluation (table 1). So few untreated spots grew in size that tests of treatment differences were inconclusive. Untreated spots contained 5 to 25 active trees, but only the two largest spots (18 and 25 trees) grew in size. None of the treatment spots broke out in the winter evaluation, and only two broke out in the summer evaluation (table 1).

Only two proliferations occurred around the study spots. Both occurred in the spring, after winter treatments. One was near an untreated spot, and the other was near a cut-and-top spot (table 1).

The buffer strip volume consistently exceeded the volume of infested trees (table 2). The infested trees contained as much as 1,159 cubic feet, and trees in the buffer strip as much as 1,598 cubic feet.

The cost of tree felling ranged from $3.95 to $21.45 per spot, including vehicle mileage and gas and oil for chainsaws. Labor to treat spots ranged from $9.63 to $183.75 (table 2). The high costs reflect problems encountered with crews (lack of training, turnover, low pay, hard work), and breakdowns of equipment.

### B. Louisiana.

Only two spots were treated with the cut-and-leave tactic during the summer of 1977, due to a general decline in the SPB activity (Kenny Jeane, personal communication; Twardus et al. 1978). Only one spot showed a positive benefit/cost ratio. Superficially, this result is misleading, because more trees were cut in the buffer strip of the treated spot than were lost due to the beetles in the treated and untreated spots (table 3). The reason so many trees were cut in the buffer strip on the August 24 spot is that the spot had three centers of activity (heads).

Table 1.--Breakouts, proliferations, and spot growth around cut-and-top, cut-and-leave, and untreated areas in North Carolina.

| Season | Treatment | No. spots treated | Percent | | |
|---|---|---|---|---|---|
| | | | Breakouts[1] | Proliferations[2] | Spot growth[3] |
| Winter | Untreated | 10 | ----[4] | 10.0 | 10.0 |
| | Cut-and-top | 10 | 0.0 | 10.0 | ---- |
| | Cut-and-leave | 10 | 0.0 | 0.0 | ---- |
| Summer | Untreated | 7 | ---- | 0.0 | 14.3 |
| | Cut-and-top | 7 | 14.3 | 0.0 | ---- |
| | Cut-and-leave | 7 | 14.3 | 0.0 | ---- |

[1] Infestation of green trees within 25 feet of the periphery of a spot following a control treatment.

[2] A new spot initiated by beetles escaping from controlled and/or uncontrolled spots located from 25 feet to one-fourth mile from the immediate periphery of the initial spot.

[3] The natural expansion of untreated spots as a result of additional green trees becoming infested.

[4] No data--treatment would not fit definition.

Table 2.--Number of spots, infested trees, basal areas, volumes, and costs in 1975-1976 North Carolina cut-and-leave and cut-and-top evaluations.

| | No. Spots | Avg. no. infested trees | Avg. total basal area | Avg. cu. ft. | | Costs | |
|---|---|---|---|---|---|---|---|
| | | | | Infested | Buffer | A[1] | B[2] |
| WINTER | | | | | | | |
| Untreated | 16 | 8 ± 5[3] (5-25)[4] | 122 ± 20 (90-160) | 72 ± 48 (0-205) | - | - | |
| Cut-and-leave | 16 | 10 ± 5 (5-17) | 110 ± 10 (90-120) | 99 ± 88 (0-319)[5] | 312 ± 257 (120-968) | 8.63 ± 4.54 (4.50-21.45) | 63.67 ± 44.87 (25.00-183.75) |
| Cut-and-top | 10 | 10 ± 6 (5-26) | 128 ± 25 (100-170) | 147 ± 255 (0-862) | 597 ± 464 (25-1598) | 4.65 ± 1.48 (3.95-9.25) | 57.67 ± 23.86 (23.40-93.60) |
| SUMMER | | | | | | | |
| Untreated | 17 | 8 ± 4 (4-18) | 96 ± 31 (50-180) | 171 ± 265 (24-1159) | - | - | - |
| Cut-and-leave | 8 | 13 ± 14 (5-47) | 124 ± 35 (90-200) | 164 ± 94 (98-333) | 296 ± 88 (127-416) | 4.94 ± 0.90 (3.00-6.00) | 55.68 ± 19.51 (36.00-97.00) |
| Cut-and-top | 7 | 8 ± 4 (5-47) | 118 ± 21 (90-150) | 82 ± 40 (30-146) | 159 ± 136 (9-174) | 4.25 ± 0.52 (3.50-5.00) | 33.86 ± 12.38 (9.63-40.50) |

[1] Vehicle mileage, chain saw gas and oil.

[2] Labor to treat spots.

[3] Average ± standard deviations.

[4] The numbers in parentheses refer to the minimum and maximum values.

[5] 0 indicates that infested trees were not merchantable.

Table 3.--Information on the cut-and-leave spots on the Kisatchie National Forest, 1977.

| | 24 Aug. '77[1] | | 6 Sept. '77[2] | |
|---|---|---|---|---|
| | Cu. ft. | No. trees | Cu. ft. | No. trees |
| Buffer strip | 333 | 49 | 70 | 6 |
| SPB-infested trees | 297 | 44 | | |
| Parent adult | N/A | | 8 | 1 |
| Larvae | N/A | | 193 | 10 |
| Pupae | N/A | | 29 | 2 |
| Black turpentine beetle | N/A | | 21 | 4 |
| Application cost | $98 | | $46 | |
| Trees lost in untreated spot by Nov. 1, 1977 | 30 | | 19 | |
| VALUE | $112 | | $31 | |

[1] Basal area (Pine:130 Hardwood:0)

[2] Basal area (Pine:150 Hardwood:0)

Of the 42 spots ground checked in the study area and found to be active on the first visit, 32 were inactive within 30 days. The remaining 10 spots were inactive 30 days later.

C. Mississippi.

As in Louisiana, only two spots were suitable for treatment during the summer of 1978 (table 4). Even though a great deal of activity occurred on the Bienville National Forest that year (Twardus 1977), salvage sales had been completed on the largest spots before the evaluation began. Of the two spots treated, only one, with 52 infested trees, should have had control measures applied. Twenty other spots were monitored in the same general area for spot growth (table 5) (Twardus et al. 1978). Eleven were inactive within 30 days after the first visit. The other nine spots were inactive by day 60.

## DISCUSSION

The cut-and-leave and cut-and-top evaluation in North Carolina showed that, under those specific conditions, cut-and-leave and cut-and-top treatments were neither necessary nor effective. The lack of significant differences between the treatments and the controls may be attributed to the general collapse of SPB populations in eastern North Carolina during the treatment period. This collapse was reflected in a steady reduction in numbers of spots detected by the North Carolina Forest Service from 1974 to 1975. Crews visited 300 spots during this evaluation and found that 100 were active. Eighty-five percent of the spots had less than 10 infested trees.

Texas Forest Service data (Billings 1977; Hedden and Billings 1979) indicate that a high percentage of small spots go inactive naturally, and inactivity rates in the small North Carolina spots may reflect the same phenomenon. The Texas Forest Service has concluded that small spots (less than 10 trees) need not be included in their detection surveys, nor treated. However, during the treatment period in North Carolina, decline in beetle activity occurred in spots of all sizes.

The major problem in applying the cut-and-leave and cut-and-top treatments to SPB spots was the unwillingness of landowners to cut an adequate buffer strip. Most owners were very reluctant to sacrifice as many (or more) trees for the buffer areas as were killed by the beetles in the spots.

Landowners in North Carolina also had an alternative to the cut-and-leave and cut-and-top treatments. The North Carolina Forest Service provided cut-and-spray crews during this period. It was difficult to convince cooperators that the cut-and-leave and cut-and-top treatments might be as effective and would be less expensive to apply. Many private landowners were unwilling to risk further losses with an unproven tactic when the North Carolina Forest Service program was available to them.

Table 4.--Information on the cut-and-leave spots on the Bienville National Forest, 1978.

| | 14 June '78[1] | | 22 July '78[2] | |
|---|---|---|---|---|
| | Cu. ft. | No. trees | Cu. ft. | No. trees |
| Buffer strip | 764 | 73 | 130 | 12 |
| SPB-infested trees | | | | |
| Fresh attacks | 455 | 33 | 38 | 3 |
| Larvae | 49 | 3 | 21 | 2 |
| Pupae & callow adults | 278 | 16 | 39 | 4 |
| Application Cost | $121 | | $19 | |
| Trees lost in untreated spot by Oct. 1, 1977 | 182 | | 14 | |
| VALUE | $738 | | $56 | |

[1] Basal area (Pine:120 Hardwood:60)

[2] Basal area (Pine:130 Hardwood:20)

Table 5.--Status of untreated spots in Mississippi 1 month after the initial ground check--1978.

| No. infested trees | No. of spots | No. active after 30 days |
|---|---|---|
| 1 | 5 | 0 |
| 2 | 1 | 0 |
| 3 | 4 | 0 |
| 7 | 2 | 1 |
| 13 | 3 | 2 |
| 16 | 1 | 1 |
| 34 | 1 | 0 |
| 39 | 1 | 1 |
| 46 | 1 | 1 |
| 132 | 1 | 1 |

At times, determining beetle activity at breast height was not possible. Several times, pitch tubes were evident on the bole of the tree but above breast height.

Cut-and-leave or cut-and-top treatments may still have potential for use under certain conditions, even if beetle populations are not reduced numerically. If these treatments force surviving beetles to disperse when they are physiologically unprepared to do so, the treatments might cause significant dispersal loss.

The efforts made in Louisiana in 1977 and in Mississippi in 1978 added little to our knowledge of cut-and-leave. However, they underscored the need to use a large number of beetle spots when evaluating control tactics. All the efforts supported the fact that small spots usually do not have to be controlled. The development of pest population models will be a tremendous aid in future evaluations of treatment tactics (Coulson et al. 1979).

Cut-and-leave is recommended by the forestry agencies in Mississippi, Texas, Tennessee, Georgia (Piedmont only), and Virginia. In northern Mississippi, cut-and-leave was used on small or inaccessible spots during the last outbreak (1976). Texas treats, by far, the largest number of active spots, accounting for about 50 percent of all spots treated in 1975 (Texas Forest Service 1976). The Texas Forest Service recommends cut-and-leave on spots containing 20 to 100 infested pines.

The Virginia Division of Forestry recommends cut-and-leave on small spots (less than 20 infested trees) during the growing season. They feel the best time to use the technique is early summer. The Tennessee Division of Forestry has recommended cut-and-leave on small spots (less than 26 active trees) since early 1975. The practice has not gained favor in Tennessee, even in view of poor or nonexistent pulpwood markets. On State forests and pulp and paper company lands in Tennessee, spray crews still handle treatments when salvage is impractical.

A forester should be aware of other pest problems when and if cut-and-leave is used. Some preventative measures for annosus root rot may be warranted on high hazard sites (Froelich et al. 1977). During periods of abnormally low rainfall, the treatment area should be monitored for Ips bark beetle buildup.

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